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The Bazaar Economy Hypothesis Revisited

A New Measure for Germany's
International Openness

by

Ansgar Belke, Anselm Mattes and
Lars Wang

Nr.285/2007



Institut für Volkswirtschaftslehre (520)
Universität Hohenheim, 70593 Stuttgart

ISSN 0930-8334

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Ansgar Belke, Anselm Mattes, Lars Wang
University of Hohenheim

Stuttgart, February 27, 2007

Paper submitted to the Annual VfS Conference Munich 2007 ("Offener Teil")

Abstract

In this paper we argue that traditional measures of openness of an economy usually overstate the actual degree. This is due to the fact that traditional export or import shares are measured as a share of the gross domestic product. The former are expressed in gross terms, the latter in value added terms. In this way the actual interdependences between economies are overstated. We develop a new value based openness indicator that includes interregional and inter-industrial dependencies. Based on a Leontief production system and input-output-tables we argue that export-induced imports of intermediate parts must be subtracted of the value of exports in order to obtain the real value added in the export sector. The same reasoning applies to the import side. We use these measures of actual openness to calculate openness indicators for Germany using GTAP data. We show that traditional measures of openness exaggerate the actual openness and argue that these new indicators are an important contribution to the debate about the German "bazaar economy".

JEL classification: C67, E20, F15, F41

Keywords: Degree of openness, openness to intra-regional trade, bilateral trade, value-added approach, input-output analysis, bazaar economy

Corresponding author: Prof. Dr. Ansgar Belke, Chair of International Economics, Department of Economics, University of Hohenheim, D-70593 Stuttgart, Germany, Phone: +49 (0)711-4593246, Fax: +49 (0)711-4593815, E-mail: belke@uni-hohenheim.de.

1. Introduction

The debate whether Germany is or is becoming a „bazaar economy” has been a quite popular one and is still going on. The hypothesis of the “bazaar economy” states that the German export boom is “pathological” because German firms outsource significant parts of production to low-wage countries. There is a trend for Germany to import more and more intermediate parts and to confine itself to merely assemble them. By this mechanism, the value added in Germany is continuously shrinking and the German economy is degenerating to a “bazaar” (see, e.g., Sinn 2006). The contrasting view emphasizes that the current account surplus is growing. Most of German imports are used for final consumption and are not applied as intermediate parts in export production. Value added in the export sector is thus rising. Additionally, Germany is not only an importer of intermediate inputs but also an exporter. So it is not the German economy which is the bazaar. Instead, the bazaar has a worldwide dimension and can be considered as a straightforward result of a higher degree of specialization (see, e.g., Zimmermann 2005).

In this paper, we argue that the traditional measures of openness used in this debate are not able to paint the full picture. For instance, the share of exports or imports of the gross domestic product (GDP) is among the traditional measures of export or and import openness most often used in the literature. According to our view, this is clearly not adequate because the export or import value is pinned down in gross terms while GDP is measured in value added terms. The aim of this paper is to develop new *measures of openness towards international trade*. In a general sense, the *degree of openness to trade* measures the importance of international trade linkages for a country. In our reading, “importance” in this context refers to the power that trading partners abroad have to influence the operation of a market economy in the home country. As is well-known from the theory of optimum currency areas, tighter connections between domestic and foreign markets are able to reduce the effectiveness of demand

stimulation by fiscal and monetary policies. For example, increased spending by domestic consumers might be directed at foreign firms. In addition, external factors have the potential to exert greater influence on domestic outcomes. For example, increased product-market competition might affect the production output, income, employment, or the price level in the domestic economy. A value of zero for the degree of openness typically indicates that the country is a closed economy in total autarky. The higher the level of openness, the more likely it is that the foreign countries have a stronger effect on the economic variables of the home country.

Shares of trade represent the traditional outcome-based concept for calculating a country's degree of openness. The realizations of these shares usually serve as proxies of openness in the empirical literature and from the starting point of the development of innovative indicators in this paper which adjusts and claims to improve on the conventional ones. Trade shares measure the value of traded goods and services in relation to a country's gross domestic product (GDP), the value of all final goods and services produced by their factors of production.

According to Kotcherlakota and Sack-Rittenhouse (2000), trade shares at the export side help to identify a country's surplus production. Its households consume, the government purchases, firms invest, and foreign residents buy the country's final goods and services produced by domestic factors of production and imported intermediate products. If foreign countries demand final goods and services, the latter can no longer be sold on the home market.

Expressed as a percentage, the openness measure *export ratio* (ER) relates the value of goods and services sold by the country to its trading partners to the value of all goods and services produced by domestic factors of production for domestic and foreign expenditure (GDP) for the period of one year. A realization of zero percent for the export ratio means that only domestic spending exists. The more open an economy is, the more the respective country is able to create a surplus production.

In addition, the *import ratio* (IR) index calculates a value which represents the importance of trade linkages for an economy from the import side by emphasizing the value of the country's imports from other nations as share of the total national income (GDP). Kotcherlakota and Sack-Rittenhouse (2000) argue that this type of measure of openness assesses the degree of the dependency of a country's residents on imported commodities and services. In the case of a zero percent value, the import ratio indicates that domestic residents demand only domestic goods and services whereas a more open country becomes more dependent on foreign goods and services.

Outcome-based adjustments of the established trade shares aim at improving the assessment of 'openness' for the purpose of cross-country comparisons. In general, the denominator of the trade shares and, thus, the gross domestic product (GDP) is corrected. For example, adjusted trade shares take the Balassa-Samuelson effect, a country's size, or its state of development into account. Such amendments seem to advance the quality of empirical analysis based on trade openness (Brahmbhatt 1998). But the adjustment of traditional openness measures along these lines might not be far-reaching enough because their construction very much disregards the fact that the usual interpretation of the conventional shares of trade is misleading.

Those applying the traditional shares of trade openness at the export side attempt to indicate a country's surplus production. In addition, it is supposed that the dependency of a country's residents on imports is measured at the import side (Kotcherlakota and Sack-Rittenhouse 2000). The interpretation of these trade shares sounds correct but our main point raised in this paper is that these indices do not indicate what they are supposed to. According to our view, the traditional shares of trade analysis is not well-suited to discuss issues like the degree of globalization simply because they do not take into account the international redistribution of income which is generated by trade. Two aspects are the main drivers of this insight.

First, exports do not exclusively create income in the country which sells goods and services to foreign countries; they also generate income in the country's trading partners due to imported intermediate inputs to produce exports. The common interpretation of a country's degree of openness to trade based on the traditional trade shares at the export side overstates the potency of a country to build surplus production at home. Second, imported intermediate products which are assembled in exports do not constitute a part of the national income of the domestic economy. Goods and services sold to foreigners only create income for the residents when the domestic factors of production are involved in the process of production. Moreover, approaches which only adjust the denominator are too short-handed to improve the quality of the export ratio. It is still a truism that the numerator simply represents only one share of the denominator.

The widespread explanation of traditional trade shares at the import side can be criticized in a similar way to the argument made above for the import side. Residents of the home country are not dependent on all parts of imports as the usual index of openness, such as the intra-regional import ratio, suggests. They have to spend a lower portion of their income to purchase goods and services from abroad. Imports are partly produced with intermediate products delivered by other countries. Of course, these "other" countries also include the home country. Hence, international trading partners purchase intermediates from the domestic economy to assemble, for example, imports for the home country which, in turn, generates income for the domestic factors of production. Domestic residents do not have to spend as much of their income as is usually calculated if one applies the traditional proxy of openness. Along these lines, Brahmabhatt (1998) points out that since "trade data is stated in gross terms, while GDP is stated in value added terms, this can lead to an inflation in" traditional measures of openness. The value of exports consists of the value of imported intermediates and the value of domestic factors of production. Value added denotes the income that domestic resi-

dents receive for their employment in the process of production. A *solution* could be either to state trade in value-added terms or to state national income in gross output terms. Astonishingly, we were not able to find a concept in the empirical literature which adheres to and follows either of these ideas. A simple reason for the lack of value-added based adjustments of traditional trade shares might be that the availability of such data is limited (Brahmbhatt 1998). Knetter and Slaughter (2001) also raise this problem with an eye on data on imported intermediate inputs.

In this paper, we develop two new measures of openness to international trade which attempt to solve the problems. We argue that our new measures significantly contribute to adjust traditional shares of trade by expressing trade in *value-added terms* instead of gross terms. This value-added based approach stands in clear contrast to the mainstream and more traditional view of economic openness. We denote degrees of openness which are calculated referring to the traditional shares of trade as ‘*traditional openness*’. However, those indicators which are based on the adjusted trade shares will be termed ‘*actual openness*’.

The remainder of this paper proceeds as follows. Section 2 presents the necessary algebra to derive a new concept of actual openness which enables us to adjust the well-established indices of openness towards trade by means of the value-added based openness proxies. Section 3 delivers some empirical realizations of the “actual” and “traditional” openness indicators for Germany based on GTAP data and confirms that the traditional indicators are biased and tend to overstate the “real” degree of openness. Section 4 finally concludes. Our analysis is completed by a detailed technical appendix.

2. Actual openness of international trade

2.1 Input-output analysis of trade relationships

Let us first recall that we strive to arrive at a new measure of openness according to which the ratio of exports to GDP and the ratio of imports to GDP are expressed in value-added terms. Moreover, the more traditional definition of openness is defined as the ratio of exports expressed in gross terms to GDP. With these definitions, this new measure corrects for the extra part, you might also call it “inflation”, of value-added that is generated in exports (imports) of intermediate goods for the production of imports (exports). The “inflation” of value-added generated with the traditional definition of *exports* in this sense corresponds with the income that is transferred abroad for the payment of imports of intermediate goods for the production exports. Accordingly, the “inflation” of value-added generated with the traditional definition of imports is identified as the part of income that is generated to domestic residents of exports of intermediate goods for the demand of imports. The computation of these new definitions is based on a theory of production, defining a multi-regional input-output table following a proposition by Isard (1951).

Let us continue with the observation that our innovative measures of trade openness adjust the traditional shares of trade by emphasizing the value added that international trade generates. Such a correction of the trade values that are stated in gross terms requires an *analysis of income effects* due to trade. The analysis must take the process of production in an economy into account since the interdependences between industries determine the employment of inputs for the production of output in the industries. Consequently, input-output analysis is the preferred and appropriate instrument for the development of new trade shares.

We have carried out a *multi-regional input-output analysis* in an open static Leontief system which describes the economic system of the world economy not only in terms of interdependent industries within a region but also in terms of the interrelated regions’ home country and

aggregated foreign country. The ‘aggregated foreign country’ region comprises all trading partners of the respective home country. A national input-output analysis of a country which ignores the process of production in the foreign countries would restrict the construction of new proxies of openness to the export side of the economy. Consequently, it is necessary to include national input-output analyses of the foreign trading partners to expand the measurement of actual openness on the import side of the country of interest because only this way of proceeding allows the international redistribution of income created by trade to be calculated. The decision to choose the *open static Leontief system* (Leontief 1966) as the theoretical foundation for the input-output analysis instead of, e.g., the Sraffa system (Sraffa 1960) was based on the insight that the Leontief contribution to the theory of production was essentially inspired by empirical concerns – as is the case in our paper as well - whereas the Sraffa system was basically developed for theoretical purposes (Pasinetti 1977, pp. 32, 71). In addition, we apply data bases of the Global Trade Analysis Project (GTAP) which offer data which only fit the Leontief system (GTAP 2005, 2003, 1999, McDougall and Dimaranan 2002 and Gehlhar et al. 1997).

Our data base does not include data to construct more comprehensive non-linear or dynamic input-output models. A linear approximation of the production processes within a country is appropriate if exports induce small variations in the production of the economy. In such a case, the output effects of increasing or decreasing returns to scale are limited. In other cases, the non-linearity of the production relationships could lead to premature and deceptive conclusions. For a short period of time, like one year, the assumption of a static economy is suitable even for noticeably dynamic economic systems because the changes in technical knowledge which affect the technical coefficients can normally be neglected (Pasinetti 1977, p. 69). In the technical appendix to this paper we describe the intra- and inter-regional economic interconnections within the well-known framework of the *multi-regional input-output table*.

These interconnections are traced and utilized by the following input-output analysis. The first step of the analysis of income effects which can be traced back to exports is the forecast of the *change of total output* in the domestic economy. Any output of an industry including goods and services sold to foreign residents requires intermediate inputs from the industry and supplying industries for the production of the output. All the industries involved also require their own intermediate commodities from their suppliers and so forth. Hence, the value of total output includes the export value and the value of all intermediate inputs to produce the exported output.

In the following, we describe the technical relationship between the value of exports that are interpreted as a change in the value of final demand and the response of the value of total output which is determined by the interdependences of the industries. For this purpose, we start with the *inter-industry coefficient* (i.e., the technical coefficient of the production processes or merely production coefficient). The inter-industry coefficient a_{ijk} represents the fraction of total expenditures of industry j which is spent to purchase the commodity i in region k as

$$a_{ijk} = \frac{X_{ijk}}{X_{jk}}, \quad i, j = 1, 2, 3, 4, \quad k = 1, 2. \quad (1)$$

This ratio expresses the quantity of the i th commodity which is on average required in the j th industry (X_{ijk}) for the production of one unit of the j th commodity (X_{jk}) in region k . Commodity i (industry j) represents food (food industry) (1), other primary products (other primary production) (2), manufactures (manufacturing) (3), or services (4). Region k indicates either the home country (1) or aggregated foreign country. Because commodities do not have negative values, it follows that

$$a_{ijk} \geq 0, \quad i, j = 1, 2, 3, 4, \quad k = 1, 2. \quad (2)$$

Equation (1) reveals the fundamental assumption of the Leontief system, i.e. the inter-industry coefficients are constant; constant returns to scale are assumed. However, price effects,

economies of scale, or changes in technical knowledge that influence the requirement for inputs to produce output in an industry are not considered. There is no substitution between inputs. When taking into account that the technology of the production process is fixed, the amount of a commodity i purchased by an industry j in region k (X_{ijk}) is determined only on the level of its output of commodity j (X_{jk}):

$$X_{ijk} = a_{ijk} X_{jk}, \quad i, j = 1, 2, 3, 4, \quad k = 1, 2. \quad (3)$$

Consequently, equation (32) (see Technical Appendix) which defines the value of the total output of commodity i in region k can be rewritten as

$$X_{ik} = \sum_{j=1}^4 a_{ijk} X_{jk} + \sum_{e=1}^2 Y_{iekk}, \quad i = 1, 2, 3, 4, \quad k = 1, 2. \quad (4)$$

The symbol Y_{iekk} indicates the value of the i th commodity which is produced in region k and demanded by the final demand component e of region k . Component e of final demand is either in the home country (1) or aggregated foreign country (2). Since the value of all outputs of an industry (X_{ik}) equals the value of all of its inputs (X_{jk} with $i = j$), X_{jk} can be replaced by X_{ik} , as stated in (35), and hence it follows that

$$X_{ik} = \sum_{j=1}^4 a_{ijk} X_{ik} + \sum_{e=1}^2 Y_{iekk}, \quad i = 1, 2, 3, 4, \quad k = 1, 2. \quad (5)$$

To find out what effect a change in the value of final demand, such as the value of exported goods and services within a year, has on the value of the total output in all industries of a region, equation (5) must be rearranged. As a first step, we rewrite the equation concisely. The column vector of the four values of the commodities i which make up the final demand in region k is represented by y_k as

$$y_k = \left(\sum_{e=1}^2 Y_{1ekk}, \sum_{e=1}^2 Y_{2ekk}, \sum_{e=1}^2 Y_{3ekk}, \sum_{e=1}^2 Y_{4ekk} \right)^T, \quad k = 1, 2. \quad (6)$$

x_k symbolizes the column vector of the four total output values of each commodity i which have to be produced in region k (X_{ik}). It can be stated as

$$\mathbf{x}_k = (X_{1k}, X_{2k}, X_{3k}, X_{4k})^T, \quad k = 1, 2. \quad (7)$$

The technique of a region k 's economic system is represented by the *direct requirements table* of the production processes A_k . It is the non-negative square matrix of inter-industry coefficients of order four which relates the inputs and outputs of commodities:

$$A_k = (a_{ijk}) = \begin{pmatrix} a_{11k} & a_{12k} & a_{13k} & a_{14k} \\ a_{21k} & a_{22k} & a_{23k} & a_{24k} \\ a_{31k} & a_{32k} & a_{33k} & a_{34k} \\ a_{41k} & a_{42k} & a_{43k} & a_{44k} \end{pmatrix}, \quad k = 1, 2. \quad (8)$$

Based on these definitions, equation (5) can be rewritten as

$$\mathbf{x}_k = A_k \mathbf{x}_k + \mathbf{y}_k, \quad k = 1, 2. \quad (9)$$

The system of linear equations states that the value of the total output of region k equals the combined value of internal and final demand. A rearrangement of \mathbf{x}_k to the left side leads to

$$\mathbf{x}_k - A_k \mathbf{x}_k = \mathbf{y}_k, \quad k = 1, 2. \quad (10)$$

By taking the identity matrix of order four (B):

$$B = (b_{rs}) = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}, \quad b_{rs} = \begin{cases} 1 & \text{for } r = s \\ 0 & \text{for } r \neq s \end{cases} \quad (11)$$

into account it follows that

$$B\mathbf{x}_k - A_k \mathbf{x}_k = \mathbf{y}_k, \quad k = 1, 2 \quad (12)$$

which leads to

$$(B - A_k) \mathbf{x}_k = \mathbf{y}_k, \quad k = 1, 2. \quad (13)$$

Symbol b_{rs} represents an element of the identity matrix with the row index r and the column index s . The final rearrangement of equation (9) results in the solution of the static open Leontief system which can be written down as:

$$\mathbf{x}_k = (B - A_k)^{-1} \mathbf{y}_k, \quad k = 1, 2. \quad (14)$$

For region k and in value terms, it states the relation between a given change in the structure of final demand and the response of the total output of the various industries necessary to produce not only the demanded commodities but also the required intermediate commodities in the production processes of the final goods and services. It is assumed that the supply of resources is infinite and perfectly elastic as well as that all resources are efficiently employed (OECD 1992). In addition, the relation between the final sector and the intermediate sector clearly shows that the values of final demand are assumed to be exogenous variables of the input-output model whereas the values of total output are considered to be endogenous variables. But components of final demand, such as households, are involved in the process of production. The level of employment affects the demand of households. Since households are a part of the economic system, they would become endogenous variables of the input-output model. This aspect of the model's design is of minor relevance for the analysis of income effects due to exports because the spending of the induced national income by the households is not investigated.

The inverse matrix of order four in (14) is the *total requirements table* of the production processes $(B-A_k)^{-1}$, which is defined in symbols as

$$(B-A_k)^{-1} = (f_{ijk}) = \begin{pmatrix} f_{11k} & f_{12k} & f_{13k} & f_{14k} \\ f_{21k} & f_{22k} & f_{23k} & f_{24k} \\ f_{31k} & f_{32k} & f_{33k} & f_{34k} \\ f_{41k} & f_{42k} & f_{43k} & f_{44k} \end{pmatrix}, \quad k = 1, 2. \quad (15)$$

Its elements are the *interdependence coefficients*, denoted by f_{ijk} . The interdependence (inter-industry) coefficient f_{ijk} (a_{ijk}) represents the quantity of the i th commodity which is required in the economic system as a whole (on average in the j th industry) for the production of one unit of the j th commodity as a final commodity (as output for intermediate and final use) in region k . Thus, the total requirements table $(B-A_k)^{-1}$ does not only measure the direct effects, like the

direct requirements table A_k , but also the indirect effects of any changes in the various industries.

As a second and a third step, the value of domestic factors of production and the value of the imported intermediate inputs that are employed in the production processes of all involved industries to produce the exports in region k are forecasted. The analysis reveals, on the one hand, how much income exports engender in the domestic economy (*domestic value added* induced by exports) and, on the other hand, how much income is transferred abroad due to the imported intermediate inputs that are processed in the exports (*foreign value added* induced by exports).

The *direct requirements table of domestic production factors* for region k , denoted by D_k , adds to the part of the direct requirements table already presented – the direct requirements table of the production processes A_k . Beside the description of the interdependences between the industries, this additional component of the table shows the structure of the production factors employed in the industries due to the production processes in the economy which, in symbols, is

$$D_k = (d_{gjk}) = \begin{pmatrix} d_{11k} & d_{12k} & d_{13k} & d_{14k} \\ d_{21k} & d_{22k} & d_{23k} & d_{24k} \\ d_{31k} & d_{32k} & d_{33k} & d_{34k} \\ d_{41k} & d_{42k} & d_{43k} & d_{44k} \\ d_{51k} & d_{52k} & d_{53k} & d_{54k} \end{pmatrix}, \quad k = 1, 2. \quad (16)$$

This matrix consists of coefficients known as *technical coefficients of the domestic production factors* (d_{gjk}). The coefficient expresses the share of total expenditure of an industry j (X_{jk}) which is spent to compensate the factor of production g in industry j (W_{gjk}) in region k :

$$d_{gjk} = \frac{W_{gjk}}{X_{jk}}, \quad g = 1, 2, \dots, 5, \quad j = 1, 2, 3, 4, \quad k = 1, 2. \quad (17)$$

Factor of production g represents unskilled labor (1), skilled labor (2), capital (3), land (4), or natural resources (5). It is assumed that the coefficients are constant, the primary inputs are

not substitutable, the production factors are not constrained, and the factors of production are efficiently employed. From the economic meaning of the coefficient it follows that

$$d_{gjk} \geq 0, \quad g = 1, 2, \dots, 5, \quad j = 1, 2, 3, 4, \quad k = 1, 2. \quad (18)$$

Next, the change in the exogenous vector of final demand values of region k is determined by the vector of export values of the various commodities i sold from region k to region l . It can be written in symbols as

$$y_k = (Y_{1lk}, Y_{2lk}, Y_{3lk}, Y_{4lk})^T, \quad k = 1, 2, \quad l \neq k. \quad (19)$$

The commodities which are represented by the vector of export values y_k require not only the production of these commodities sold by foreign residents, but also intermediate commodities in the industries at the different levels of the stages of production within the economy, that is, the change of total output of the various industries expressed in value terms. This association is stated in (14). In addition to the intermediate commodities, domestic factors of production (and imported intermediate commodities) are employed in the production process of the exports. The compensation of the different factors of production g in region k is defined by the column vector of income of domestic production factors q_k as

$$q_k = (Q_{1k}, Q_{2k}, Q_{3k}, Q_{4k}, Q_{5k})^T, \quad k = 1, 2. \quad (20)$$

Using the direct requirements table of domestic production factors D_k , the income of the production factors q_k due to the direct and indirect employment in the production of exports in region k is

$$q_k = D_k x_k, \quad k = 1, 2. \quad (21)$$

Hence, it follows that the *export-induced domestic value added* of region k represents the total income of the different production factors g in region k generated by exports.

Finally, the *direct requirements table of imported intermediate products* for region k (C_{lk}) completes the direct requirements table and is defined in symbols as

$$C_{lk} = (c_{ijkl}) = \begin{pmatrix} c_{11lk} & c_{12lk} & c_{13lk} & c_{14lk} \\ c_{21lk} & c_{22lk} & c_{23lk} & c_{24lk} \\ c_{31lk} & c_{32lk} & c_{33lk} & c_{34lk} \\ c_{41lk} & c_{42lk} & c_{43lk} & c_{44lk} \end{pmatrix}, \quad k=1,2, \quad l \notin k. \quad (22)$$

Its elements – the *technical coefficients of the imported intermediate inputs*, denoted by c_{ijkl} , – express the quantity of the i th commodity imported from region l which is essential in the j th industry for the production of one unit of the j th commodity in region k . The ratio can be written as

$$c_{ijkl} = \frac{X_{ijlk}}{X_{jk}}, \quad i, j = 1,2,3,4, \quad k = 1,2, \quad l \notin k. \quad (23)$$

The assumptions about the employment of the imported intermediate commodities in the production process of output are identical to those for the production factors presented earlier. In addition, only positive values of the coefficient are economically plausible:

$$c_{ijkl} \geq 0, \quad i, j = 1,2,3,4, \quad k = 1,2, \quad l \notin k. \quad (24)$$

We will now introduce the last vector of the input-output analysis of income effects due to international trade which represents the value of imported intermediate commodities i in region k bought from region l . The column vector p_{lk} is expressed in symbols as

$$p_{lk} = (P_{1lk}, P_{2lk}, P_{3lk}, P_{4lk})^T, \quad k = 1,2, \quad l \notin k. \quad (25)$$

The demand for exports triggers the production of these final commodities as well as inducing the intermediate commodities to produce goods and services that foreign residents desire. This change in total output requires, beside domestic inputs, intermediate commodities from abroad as determined by the structure of production within the industries:

$$p_{lk} = C_{lk} x_k, \quad k = 1,2, \quad l \notin k. \quad (26)$$

Finally, the *export-induced foreign value added* of region k indicates the value of all imported intermediate commodities i of region k which are included in the region's exports.

2.2 Value-added based measures of openness towards an integration area

Trade generates value added in a country as a result of its exports (q_1 ; $k = 1$ in equation (21)). The exports within the period of one year (y_1 ; $k = 1$ in (19)) require not only the production of the export products, but also intermediate commodities in the production processes of the exporting industries and their supplying industries. This production of final commodities and additional intermediate commodities is represented by the change of total output (x_1 ; $k = 1$ in (14)) which is expressed in value terms. In addition to the intermediate commodities, the directly and indirectly involved industries employ primary inputs, such as domestic factors of production. The compensation of the production factors equals the change in the industries' value added (q_1). If we express this part of national income as a share of the whole national income in the domestic economy (Y_1 ; $k = 1$ in (36)) we obtain the *export-induced domestic value-added ratio* openness indicator, abbreviated by EDR. It can be written in symbols as

$$y_1 = (Y_{1211}, Y_{2211}, Y_{3211}, Y_{4211})^T, \quad x_1 = (B - A_1)^{-1} y_1, \quad q_1 = D_1 x_1, \quad (27)$$

$$EDR = \frac{q_1}{Y_1} 100.$$

Since the numerator represents a part of the denominator, the range of the value-added based index of openness is between zero and 100 percent. The adjusted trade ratio can be interpreted in such a way that a higher degree of openness means that a country depends more on foreign countries in the integration area to create income in the domestic economy.

A further attempt to measure the degree of openness with more accuracy than the traditional shares of trade is the *import-induced foreign value-added ratio* (IFR) indicator. This proxy of openness calculates the degree of openness on a country's import side for the period of one year with the focus on income that imports generate abroad. Identical to the exports of the country, the exports of its foreign trading partners (y_2 ; $k = 2$ in (19)) engender income for the production factors which are directly and indirectly involved in the production process of the

output (q_2 ; $k = 2$ in (21)). The contribution of this foreign income to national income of the domestic economy (Y_1) can be expressed in symbols as

$$y_2 = (Y_{1122}, Y_{2122}, Y_{3122}, Y_{4122})^T, \quad x_2 = (B - A_2)^{-1} y_2, \quad q_2 = D_2 x_2, \quad (28)$$

$$\text{IFR} = \frac{q_2}{Y_1} 100.$$

It is possible that the non-negative level of openness calculated by the IFR measure surpasses 100 percent. Such a situation indicates that domestic residents spend more of their income on imported intermediate commodities embodied in exports than they are compensated for by the industries. The domestic economy must be able to close its financial deficiency by means of exports or international borrowing. The higher the degree of openness is, the more important are foreign trading partners within the integration area for the spending of domestic residents' income.

3. Empirical Evidence

3.1 The data set

As a starting point of our empirical analysis, we calculate and present the empirical realizations of the degree of openness of Germany for the years 1995, 1997, and 2001 according to the traditional and actual openness concept. The Global Trade Analysis Project (*GTAP*) Data Base Version 4, 5.4, and 6 (GTAP 1999, 2003, 2005) are the source of data for our calculation of the trade shares. These frequently used data bases represent the economic conditions for 45 (GTAP 4), 78 (GTAP 5.4), and 87 (GTAP 6) regions and the economic linkages between these regions for the years 1995 (GTAP 4), 1997 (GTAP 5.4), and 2001 (GTAP 6) in US dollar terms. In addition, these interdependences are established and described for 50 (GTAP 4), 57 (GTAP 5.4 and 6) commodities. The industries employ five different factors of production: unskilled labor, skilled labor, capital, land, and natural resources (McDougall and Dimaranan 2002). Subsequently, the commodities are aggregated to four commodities; food, other pri-

mary products, manufactures, and services. However, the aggregation level of the production factors remains unchanged.

The source of data of the matrices of the region ‘home country’ of the multi-regional input-output table, as illustrated in the Technical Appendix, is the national input-output table of an individual state of interest of the GTAP data base. In order to retrieve the data of the matrices of the region ‘aggregated foreign country’, the national input-output tables of all trading partners are aggregated to form a single national input-output table. Then the intra-regional trade is removed from the data and Germany – the country under investigation – is subtracted. After the aggregation of national input-output tables of all countries in the GTAP data base and the subtraction of the region ‘home country’, the data of the trade patterns among the regions are corrected.

In the wake of the construction of the multi-regional input-output table the measures of openness can be calculated. Data for the computation of the traditional (value-added based) measures of openness *ER* and *IR* (*EDR* and *IFR*) can be retrieved directly (by means of the multi-regional input-output analysis as presented in the previous section) from a multi-regional input-output table.

3.2 Outcomes and interpretation

We computed the actual openness indicators for the export (*EDR*) and import side (*IFR*). On basis of the data available we retrieved results for the year 1995, 1997, and 2001. The results show an economic significant difference between the traditional measures *ER* and *IR* on the one hand and the actual openness indicators *EDR* and *IFR* on the other hand.

Table 1 presents the *outcomes* of the measures of openness of both the value-added based and traditional openness concept on the export and import side of Germany with respect to the rest of the world. Additionally the ratio of the two indicator values is displayed. This facilitates

comparison between the two concepts and shows to what extent the traditional openness measures misestimates Germany's actual international trade integration.

Table 1: Actual and traditional openness to trade of Germany (percent of current GDP)

Year	Export side			Import side		
	EDR	ER	EDR as share of ER	IFR	IR	IFR as share of IR
1995	19.7	23.8	83.0	23.0	23.4	98.2
1997	22.1	27.4	80.8	25.4	25.9	98.1
2001	26.5	34.1	77.8	30.3	30.9	98.0

Source: Own calculations based on GTAP (1999, 2003, 2005).

A degree of openness of zero percent of the gross domestic product indicates a totally closed economy. The higher the empirical value is, the more significant is the world economy, with respect to their trade relationships for the country of interest. A closer inspection of Table 1 reveals that all empirical realizations of the degree of openness indicate a lower importance of Germany's trading partners when they are calculated by value-added based measures of trade openness instead of indicators of the established openness concept. Both methods describe the same economic situation a country faces but the new approach clearly reveals that exports create less income in the producer country than suggested by the standard trade shares. Export sectors and their supplying sectors' demand imported intermediate commodities to produce exports that increase the wealth abroad rather than in the domestic economy.

For example, Table 1 demonstrates that the results of the alternative measures of openness to international trade range between 26.5 and 34.1 percent of the gross domestic product in the year 2001. Germany exports 34.1 percent of all final goods and services (ER). According to the EDR measure, these exports lead to domestic income which amounts to 26.5 percent of the total earnings in Germany. This means that an export value of 1 Euro leads to an income of 78 cents. Within the same year, the expense for imports from abroad represents a share of 30.9 percent of the national income (IR). 30.3 percent of the income that the domestic production factors receive is transferred to other states since imports include exported intermediates

which create income in Germany (IFR). Hence, 98 percent of the import value generates income abroad.

A view on the short time span we can observe shows that the spread between the traditional export ratio and the *export-induced domestic value-added ratio* increased. While both measures demonstrate that Germany is becoming more open to exports over time, the *ER* measure increased at a higher speed. In 1997 the *EDR* made up 83 % of the *ER*, which means that on average one Euro of export value generated income of 83 cents. This ratio declined to less than 78 % in 2001. This shows that value-added in Germany rose not as fast as the gross value of exports, which implies that the share of intermediate products used in export production increased. This goes in line with the much discussed “bazaar effect”.

Contrary to this, the ratio of traditional *import openness* and the *IFR* did not change much in time. Both measures displayed a nearly identical development and reflect Germany’s increasing openness towards imports. Consequently the ratio of both measures didn’t change significantly and ranged between 98.2 percent in 1995 and 98.0 percent in 2001. This means that on average 1 Euro import value of goods or services generated 98 cents of income abroad and 2 cents in Germany. The difference between the *ER/EDR* ratio and the *IR/IFR* ratio reflects the fact that Germany is relatively small compared to the rest of the world.

4. Conclusions

The concept of trade openness is broadly applied as a potential predictor, e.g., of the success of a common currency area, in numerous empirical studies, despite the fact that no commonly accepted approach of measuring openness has been developed. We have shown that the most widely applied (‘traditional’) openness indices are not able to accurately calculate the degree

of trade openness. For example, the export ratio, which relates the value of exports to the gross domestic product, can easily exceed 100 percent because trade is stated in gross terms, while the gross domestic product is expressed in value-added terms. This implies a negative (!) value of domestic non-tradeables. Many openness concepts try to *adjust* the traditional measures of openness with an aim to increase the quality of indication, but most of these attempts show a poor correlation with the traditional concept. This might indicate that the alternative approaches capture different aspects of trade openness.

In this contribution, we have developed innovative value-added based ('actual') measures of openness towards international trade. They are based on a multi-regional input-output analysis of income effects due to trade. In clear contrast to the mainstream, the actual openness concept corrects the traditional concept by expressing trade in value-added terms instead of gross terms. All surveyed alternative openness approaches disregard the fact that the general interpretation of the traditional concept is misleading. The point we raise here is that traditional openness measures do not take the international redistribution of income generated by trade into account. This means, for example, that the export ratio overstates the potential of a country to build a surplus in output at home because imported intermediate commodities that are employed in the process of production of exported commodities generate income abroad. The import ratio, which expresses imports from abroad as a share of the gross domestic product, overstates the dependence of an economy on imports since residents have to spend a lower portion of their income to purchase imports. Imports are partly produced with intermediate commodities delivered by the country that creates income for its production factors.

We argue that the innovative actual openness concept developed in this paper is able to reflect the different structures of production among countries since the value-added created by trade is derived based on a sound theory of production. This enables us to quantify the effects of the interdependences of industries within an economy. Open economies consist of more firms

that import intermediate of final commodities for the purpose of their re-export than closed economies. These firms which redistribute final commodities or process the finishing of imported intermediate commodities tend to employ less domestic factors of production and thus contribute less to national income than other firms which produce exports primarily with national intermediate commodities in all processing stages. This phenomenon is often overlooked but means that the more open economies are, the smaller the proportion of domestic production factors in the production process of exports is and the additional income earned from the selling of exports is again transferred abroad by means of imported intermediate commodities employed in exports. None of the approaches of openness measurement reviewed include this important aspect of international trade.

The expression of trade in value-added terms, based on the Leontief theory of production, is an outstanding feature of our new actual openness concept whose accuracy is higher than that of more traditional measures of indicating trade openness.

Seen on the whole, thus, results based on the computation of these new openness measures clearly demonstrate lower openness ratios compared to those obtained from the traditional definitions as outlined above. Hence, applications of our value-added based measures of openness might include the popular discussions about the quantitative importance of trade in and outsourcing of services, the significance of the label “export world champion” for a country like Germany, the debate on the “Bazaar Economy” in Germany and - in a more general context - how far globalization has gone in the past.

Our empirical results show that traditional measures of openness towards trade tend to overstate the actual openness. Additionally, we show that the gap between these measures widened with respect to the export side over the last years. In 1995 1 Euro of exports generated an increase in income of 83 cents; in 2001 it was only 78 cents. The additional value added induced by one unit of export clearly decreased over the years 1995 to 2001. This gives some

support to the “bazaar thesis” which states that Germany’s export boom is “pathological” not least because it mostly reflects an increase in imports of intermediate goods and does not increase domestic value-added.

On the other hand, a look at both measures reveals that the absolute value of exports as well as value added in export production increased significantly between 1997 and 2001. This piece of evidence demonstrates that Germany has profited in absolute terms from international trade integration and globalization. The German export boom has created additional value added and income in Germany, so it is not appear to be overall adequate to apply the term “pathological” in this context. We leave a more detailed input-output table based analysis of this question to further research but feel legitimised to argue that the traditional measures of openness are most probably not suitable for any in-depth-analysis of this matter. Our methodology developed in this paper might be a good starting point and quite helpful in that respect.

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Technical Appendix: Multi-regional input-output table

The *multi-regional input-output table* in this study systematically defines all transactions within a certain country and the aggregated foreign countries as well as between the regions. Its construction is based on the scheme proposed by Isard (1951) but with a crucial extension. The approach of Isard (1951) focuses on the analysis of regional and interregional flows of commodities. Accordingly, the input-output table of Isard (1951) disregards the endowments of factors of production. We include this second type of transactions for both regions. Only with this advancement it is possible to analyze the income effects of international trade. This method is superior to others, such as Leontief (1966), because it incorporates less simplifying assumptions of interregional interconnections. Consequently, this allows a very detailed study of the economic interdependences but it also demands a lot of data which the GTAP (2005, 2003, 1999) data bases are able to supply. The multi-regional input-output table consists of the national input-output table of a country under investigation and the national input-output tables of its trading partners which are then aggregated to build a national input-output table for the ‘aggregated foreign country’ region.

This aggregation of national input-output tables deviates from the idea developed by Isard (1951) of including each country of interest in the multi-regional input-output table. With the construction of a single national input-output table it is possible to significantly reduce the complexity of the creation of value-added based measures of trade openness. On the other hand, this approach could lead to an aggregation error due to a simplified representation of interdependences between regions (see, for example, Mythili 1995, Kossov 1970, und Theil 1957). The quality of the approximate results could be evaluated by comparing the total output predictions with a multi-national input-output table which consists of all relevant national input-output tables. Since imports from a certain country are only a fraction of total imports,

they generally induce little changes in every single trading partner. Therefore, this approximation of interconnections between the foreign countries should be legitimate.

Figure 1 illustrates the multi-regional input-output table.

Figure 1: Multi-regional input-output table with two regions

		Region <i>l</i>								Region <i>l</i>					
		1				2				1		2			
		Industry <i>j</i>								Demand <i>e</i>					
		1	2	3	4	1	2	3	4	1	2	1	2		
Region <i>k</i>	1	Commodity <i>i</i>	X_{ij11}				X_{ij12}				Y_{ie11}		Y_{ie12}		X_{i1}
	2	Commodity <i>i</i>	X_{ij21}				X_{ij22}				Y_{ie21}		Y_{ie22}		X_{i2}
Factor <i>g</i>	1														
	2														
	3	W_{gj1}				W_{gj2}									
	4														
	5														
		X_{j1}				X_{j2}									

The input-output table is constructed in current dollar terms which refer to a period of one year. The symbol X_{ijkk} represents an element of the *intermediate inputs matrix* of region k . It denotes the value of commodity i which is delivered to industry j within region k . Region k represents either the home country (1) or the aggregated foreign country (2). Commodity i symbolizes food (1), other primary products (2), manufactures (3), or services (4). Correspondingly, industry j stands for food industry (1), other primary production (2), manufacturing (3), or services (4). It is assumed that each industry produces only one type of product and each product within the industry is the same. For example, manufacturing produces only manufactured products. The distribution and sale of the manufactures is fixed. Furthermore, region k exports the value of commodity i to industry j of region l , denoted by the symbol X_{ijkl} . Region l indicates either the home country (1) or the aggregated foreign country (2).

Since these exports of one region are imported intermediate inputs for the other region, X_{ijkl} is an ingredient of the *primary inputs matrix* of region l .

The *demand matrix* of region k includes the value of the i th commodity which is produced in region k and demanded by the final demand component e of region k , indicated by the symbol Y_{iekk} . This component e of final demand is either in the home country (1) or in the aggregated foreign country (2). Thus, Y_{ikkk} represents the value of purchases of consumers and the government as well as the value of investment activities of firms of commodity i in the region k whereas the symbol Y_{ilkk} describes the export value of commodity i of region k which the residents in region l demand. This definition of final demand can be expressed as

$$\sum_{e=1}^2 Y_{iekk} = Y_{ikkk} + Y_{ilkk}, \quad i = 1, 2, 3, 4, \quad k = 1, 2 \quad l \notin k. \quad (29)$$

The exports of commodity i of region k include deliveries to the production processes as well as to final demand in region l . Since it is assumed that the value of an exported commodity i equals its import value, the export value of commodity i of region k is in symbols:

$$Y_{ilkk} = \sum_{j=1}^4 X_{ijkl} + \sum_{e=1}^2 Y_{iek l}, \quad i = 1, 2, 3, 4, \quad k = 1, 2, \quad l \notin k. \quad (30)$$

As an element of the *demand matrix*, the symbol $Y_{iek l}$ denotes the value of commodity i which the final demand component e of region l imports from region k . With this approximation of trade relationships between the regions, (29) can be rewritten as

$$\sum_{e=1}^2 Y_{iekk} = Y_{ikkk} + \sum_{j=1}^4 X_{ijkl} + \sum_{e=1}^2 Y_{iek l}, \quad i = 1, 2, 3, 4, \quad k = 1, 2 \quad l \notin k. \quad (31)$$

In contrast to the common definition of final demand, this version separates explicitly the exports of intermediate inputs from exported final products. Consequently, the value of the exported commodity i is included two times in the multi-regional input-output table. On the one hand, as part of the final demand of region k (Y_{ilkk}) and, on the other hand, as imports in region l (X_{ijkl} and $Y_{iek l}$). This treatment of exports enhances the approach of Isard (1951). Our

multi-regional input-output table describes the interregional interdependences more accurately than the alternative scheme because imports from the other region for the final demand are included in the final sector and not simplified as intermediate inputs for the industries which then deliver the imports to the final sector.

X_{ik} symbolizes the value of *total output* of commodity i in region k . It is determined by the requirement of the intermediate input i by all industries j to produce output (X_{ijkk}) and the demand of the final product i by the components e of final demand (Y_{iekk}), which is represented in symbols as

$$X_{ik} = \sum_{j=1}^4 X_{ijkk} + \sum_{e=1}^2 Y_{iekk}, \quad i = 1, 2, 3, 4, \quad k = 1, 2. \quad (32)$$

As noted before, the multi-regional input-output table in this study treats trade between the regions in such a way that the structure of exports are reflected in more detail as the scheme of Isard (1951). This enhances the analysis of the regional distribution of export induced value added. If we take (31) into account then the value of total output of commodity i in region k which is expressed in (32) becomes

$$X_{ik} = \sum_{j=1}^4 X_{ijkk} + \sum_{j=1}^4 X_{ijkl} + Y_{ikkk} + \sum_{e=1}^2 Y_{iekl}, \quad i = 1, 2, 3, 4, \quad k = 1, 2, \quad l \neq k. \quad (33)$$

The equation shows the flow of commodities i to the intermediate sector of region k and region l (X_{ijkk} and X_{ijkl}), to final demand within region k (Y_{ikkk}), and to the final sector of region l (Y_{iekl}).

Furthermore, an industry requires several inputs to carry on its activities. The sum of all inputs of the industry is called total output – the same as the sum of outputs of the industry. Industries purchase intermediate commodities from other industries (X_{ijkk}) and employ imported intermediate inputs (X_{ijkl}) as well as domestic factors of production (W_{gjk}). The symbol W_{gjk} denotes the compensation of production factor g in industry j in region k and is the missing element of the *primary inputs matrix* of region k . Factor of production g is unskilled labor (1),

skilled labor (2), capital (3), land (4), or natural resources (5). Thus, the value of *total output* of industry j in region k , denoted by X_{jk} , is defined in symbols as

$$X_{jk} = \sum_{i=1}^4 X_{ijk} + \sum_{i=1}^4 X_{ijlk} + \sum_{g=1}^5 W_{gjk}, \quad j = 1, 2, 3, 4, \quad k = 1, 2, \quad l \notin k. \quad (34)$$

The value of total output in (32) (and (33)) equals the outcome in (34) because the value of all outputs of an industry is exactly the same value as all of its inputs:

$$X_{ik} = X_{jk}, \quad i = 1, 2, 3, 4, \quad j = i, \quad k = 1, 2. \quad (35)$$

Finally, the multi-regional input-output table includes also the *gross domestic product* in region k , denoted by the symbol Y_k . The gross domestic product is defined as the sum of the value added in the industries which industries generate in the domestic economy due to their compensation of production factors for their employment in the production process of outputs. Because domestic residents spend a part of this income on domestic final goods and services and the industries export part of their outputs to foreign residents, gross domestic product can be expressed in symbols as

$$Y_k = \sum_{g=1}^5 \sum_{j=1}^4 W_{gjk} = \sum_{i=1}^4 \sum_{e=1}^2 Y_{iekk} - \sum_{i=1}^4 \sum_{j=1}^4 X_{ijlk}, \quad k = 1, 2, \quad l \notin k. \quad (36)$$

The value of imported intermediate inputs is subtracted from the value of final demand because domestically produced final goods and services include imported intermediate inputs which do not generate value added in the home economy.

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